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RA-21-03642

U.S. Department of Transportation
Docket Operations
1200 New Jersey Avenue SE
West Building Ground Floor, Room W12-140
Washington DC 20590

Subject: Submittal of revised "Statement of No Adverse Effect on Safety" in support of "Petition for Time-limited, Partial Exemption from Title14 Code of Federal Regulations Sections 25.901(c), 25.361(b) Special Condition 25-ANM-78 Item No. 6, 25.903(c), and Part 25 Appendix K, K25.1.1 for Fan Blade Out Failure"

Model: 777-200, 777-300 Aircraft with Pratt & Whitney Engines

Reference:

a) Boeing Letter RA-21-02157, "Petition for Time-limited, Partial Exemption from Title 14 Code of Federal Regulations sections 25.901(c), 25.361(b) Special Condition 25-ANM-78 Item No. 6, 25.903(c), and Part 25 Appendix K, K25.1.1 with respect to fan blade out failure", dated July 29, 2021
b) Boeing Letter RA-21-02252, "Replacement of Docket Document ID# FAA-2021-0673-001 with corrected document", dated August 10, 2021
c) Boeing Letter RA-21-02999 dated October 24, 2021, "Notification of Completion of Comparative Safety Assessment in support of 'Petition for Time-limited, Partial Exemption from Title 14 Code of Federal Regulations Section 25.901(c), 25.361(b) Special Condition 25-ANM-78 Item No. 6, 25.903(c), and Part 25 Appendix K, K25.1.1, for Fan Blade Out Failure'."

This letter is to submit: Updated "Statement of No Adverse Effect on Safety" in Reference (b) in support of the requested Time-Limited Exemption (Docket ID# FAA-2021-0673).

The Boeing Company submitted "Petition for Time-limited, Partial Exemption from Title14 Code of Federal Regulations Sections 25.901(c), 25.361(b) Special Condition 25-ANM-78 Item No. 6, 25.903(c), and Part 25 Appendix K, K25.1.1 for Fan Blade Out Failure" per reference (a), and resubmitted the petition per reference (b). Boeing completed the Comparative Safety Assessment identified in "Statement of No Adverse Effect on Safety" section of the petition, notified the public of its completion and conclusions via reference (c).

Based upon the Comparative Safety Assessment, The Boeing Company provides the following supplement to the reference (b) in the form of a revised "Description of Issue" and "Statement of No Adverse Effect on Safety":

Description of Issue

Recent FBO Events:

Three Boeing model 777 airplanes powered by Pratt and Whitney engine PW4000 experienced large span Fan Blade Out (FBO) events that led to unexpected departure of nacelle structure:

February 13, 2018, Honolulu – portions of the inlet and fan cowl structure departed.
December 4, 2020, Okinawa – portions of the fan cowl structure departed.
February 20, 2021, Denver – portions of the inlet and fan cowl structure departed.

Additionally, during the Denver event the airplane experienced loss of flammable fluid and core compartment fire.

All of these events are or have been the subject of formal investigation by the responsible regulatory agencies, leading to the following National Transportation Safety Board (NTSB) and Japanese Transportation Safety Board (JTSB) reports:

- Honolulu Event: February 13, 2018 - DCA18IA092
- Okinawa Event: December 4, 2020 - ENG21WA007
- Denver Event: February 20, 2021 - DCA21FA085

Ongoing root cause corrective action (RCCA) from the events has identified previously unforeseen FBO event vulnerabilities for the inlet, fan cowl, fan cowl support beam, and engine. In July 2020, the Federal Aviation Administration (FAA) provided clarification regarding 14 CFR 25.901(c) compliance expectations for unsecured nacelle components as a result of the recent FBO events. All of the identified vulnerabilities must be addressed in order to restore full compliance to 14 CFR 25.901(c) and the latest regulatory expectations. Additionally, compliance to 14 CR 25.901(c) is required to support compliance to 25.361(b), 25.903(c), and K25.1.1.

Boeing is proposing a multi-phased approach, including Type Design changes, to address the potential effect of an engine fan blade failure on 777 airplanes equipped with Pratt & Whitney (P&W) engines.

FBO Related Enhancements Prior to Return to Revenue Service:

Before the aircraft is returned to revenue service, Boeing recommends the following safety actions for all 777 airplanes equipped with P&W PW4000-112 engines:

- Inlet modifications: Ballistic shielding and metallic reinforcement of the engine inlet to prevent parts departing an airplane.
- Thrust reverser modifications: Installation of a debris shield to further mitigate a possible engine fire.

Implementation of these modifications requires a time-limited partial exemption for the reasons specified above. Additional safety actions which do not require exemption, including improved fan blade inspections methods and intervals, will be implemented concurrently.

Granting a time-limited partial exemption will allow Boeing to build and install the foregoing safety enhancements before the airplanes are returned to revenue service.

For the airplane configuration proposed for return to revenue service, Boeing will make a showing of full compliance to the regulations listed above for all changed and affected structure except fan cowl, fan cowl support beam and engine structural elements.

FBO Related Enhancements Post Return to Revenue Service:
In order to show and find full compliance with the regulations listed above for the FBO failure condition, those design enhancements described above and all of the following design enhancements to the engine nacelle and engine will be required:

Fan Cowl and Fan Cowl Support Beam Modifications:
Fan cowl and fan cowl support beam modifications will be implemented to ensure nacelle retention in the event of an engine fan blade failure. These modifications are currently under development and may include strengthening of the fan cowl support beam, modification of the existing fan cowl composite panels, and/or new redesigned fan cowl composite panels.

Inlet Modifications:
Additional inlet modifications may be necessary to accommodate the Fan Cowl Support Beam modifications.

Engine Modifications:
Pratt & Whitney will incorporate engine modifications to address additional hazards resulting from the FBO event, including engine flange separation and fire contributors.

Statement of No Adverse Effect on Safety

Boeing uses an FAA-approved Safety Management System (SMS) to manage the Pratt & Whitney-powered 777 fleet and ensure the highest levels of safety. Boeing's SMS process has identified a set of modifications that address all known root causes of the relevant fan blade out (FBO) events and resulting impacts to the engine nacelle. As documented in reference (c), Boeing completed a Comparative Safety Assessment showing that implementation of each modification, and the combination of modifications proposed for certification, prior to return to revenue service will reduce risk of an unsafe outcome as compared to the unmodified design.

Over the time period requested for partial exemption, the risk of a FBO-related unsafe condition occurring within the fleet with the improved engine fan blade inspection methods and inspection intervals is extremely improbable. The revised inspection methods and intervals developed by Pratt & Whitney and independently validated by Boeing, the FAA, and other industry experts are in place to reliably detect internal blade cracks prior to failure. The risk of an unsafe condition arising over the requested partial exemption interval is extremely improbable.

Implementation of the inlet and thrust reverser modifications proposed for return to revenue service will further improve safety as documented by reference (c).

Inlet Modifications
Consistent with 14 CFR 25.901(c), Boeing has performed extensive analysis to ensure that the modified inlet will not depart the airplane, should an FBO event occur where the engine flange remains fully intact. In addition, airplane-level analysis has been performed to show that the effects of the inlet modifications do not generate any additional hazards during engine spooldown following FBO (per 14 CFR 25.361(b)) or subsequent windmilling (per 14 CFR 25.903(c)). Retention of the inlet significantly minimizes the risk that a maximum Extended-range Twin-engine Operations Performance Standards (ETOPS) diversion time cannot be completed (per 14 CFR Part 25, appendix K25.1.1) if an FBO event were to occur during long haul operations.

Thrust Reverser Modifications
Boeing has assessed the installation of a thrust reverser debris shield as a mitigation to a possible engine fire, should an FBO event with engine flange separation occur. Further it has been assessed that this modification has no impact to FBO loads (per 14 CFR 25.361(b)) nor to windmilling loads requirements (per 14 CFR 25.903(c)). Ensuring mitigation of a possible engine fire, further minimizes the risk that a maximum ETOPS diversion time cannot be completed (per 14 CFR Part 25, appendix K25.1.1).

After return to revenue service, Boeing will utilize the temporary exemption to certify and release additional type design modifications via service bulletin to further enhance safety to the inlet, fan cowl, fan cowl support beam, and engine and restore full compliance upon installation of all design changes under this exemption. The incremental release of the modifications will allow operators to incorporate the changes as soon as they become available. In addition, for any future modifications, Boeing will update the comparative safety assessment to assure that each proposed modification or set of modifications does not have an adverse effect on safety. Future modifications are currently anticipated to include:

Fan Cowl & Fan Cowl Support Beam
Fan cowl and fan cowl support beam modifications will be implemented to ensure retention in the event of an engine fan blade failure. Analysis will be performed to ensure that these modifications do not generate any additional hazards during engine spooldown following FBO (per 14 CFR 25.361(b)) or subsequent windmilling (per 14 CFR 25.903(c)). Retention of the fan cowl and fan cowl support beam have no significant impact on the ability for the airplane to achieve maximum ETOPS diversion time (per 14 CFR Part 25, appendix K25.1.1).

Engine Modifications
Pratt & Whitney will incorporate engine modifications to address additional hazards resulting from the FBO event, including engine flange separation and fire contributors.

Upon completion of the certification and installation of these modifications, the propulsion system installation will be fully compliant to 14 CFR §§ 25.901(c) and 25.903(c), item #6 Engine Torque Loads of Special Conditions 25-ANM-132 2, and appendix K25.1.1 to 14 CFR Part 25.

Through its Safety Management System and ongoing coordination with the FAA, Boeing will continue to monitor the fleet to ensure that it meets FAA standards for continued airworthiness. Boeing and Pratt and Whiney are committed to designing, certifying building and installing all changes required for a full showing of compliance within the proposed time-limited partial exemption period.

Sincerely,

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Name	Letter	Enclosures	Comments
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Jim Voytilla	SP	SP	AIR-861
Ian Won	SP	SP	AIR-860
Tom Thorson	MC	MC	AIR-862
Jennifer Rasmussen	MC	MC	AIR-863
Paul Bernado	MC	MC	AIR-780